DEVELOPMENT OF A DYNAMIC ENERGY BALANCE TO ASSESS OPERATING EFFICIENCY OF THE BURLINGTON COUNTY BIOREACTOR LANDFILL IN NEW JERSEY (USA)

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Bioreactor landfill technology has been extensively employed to enhance biodegradation and stabilization to decrease long-term environmental risks and landfill operating and post-closure costs. However, recovering the more abundant amounts of biogas has not achieved the same priority that facilitating waste stabilization itself has. In fact, many leachate-recirculation and biogas-collection strategies employed in modern bioreactor landfills in the United States are designed and operated to merely meet regulated environmental standards rather than to achieve maximum biogas production and energy recovery. While meeting environmental standards is of vital importance to bioreactor landfill operators, additional national and international focus on energy concerns has now forced the concept of viewing municipal solid waste (MSW) as a necessary biofuel as well. Previously published studies have utilized life-cycle analysis and linear models to generate theoretical energy balances for various waste-management schemes. While these models are useful for considering the design of new systems, immediate energy use and biogas production augmentation measures for existing bioreactor landfill systems need to be evaluated by an appropriate energy balance to assess the operating efficiency of the specific system of interest. The objective of this study is to develop a dynamic energy balance for the bioreactor landfill in Burlington County, New Jersey (USA). Development of a dynamic system-specific energy balance is important as it will provide the means by which energy conservation and biogas production enhancements can be quantified over time. Additionally, the research will seek to not only provide additional academic understanding of bioreactor landfill systems, but will also provide a tool for operators to assess and control energy efficiency.

The Burlington County bioreactor landfill started operation in 1999, covers 28 ha, and has a maximum height of 35 m. Leachate from the bioreactor landfill, leachate from an adjacent conventional landfill, and leachate from a biofilter from a sewage sludge composting facility are introduced as liquids. Excess liquids are hauled off-site to a wastewater treatment facility. MSW collection and placement, leachate removal and treatment, and most importantly biogas generation (collected and lost) are within the system boundary of the energy balance. A simplified balance can be expressed by Equation 1.

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Existing operating data, which are continuously updated as new data become available, are used to develop the dynamic energy balance. Biogas energy generation (collected and lost), E_{biogas}, is a function of the deposited MSW as well as the rate of biodegradation. Biogas generation is predicted with a simple decay model and collected biogas is quantified by measuring actual biogas recovery rates. Incoming and exiting waste stream transportation energy requirements, $E_{transport(in)}$ and $E_{transport(out)}$ respectively, are equated to the sum of the necessary fuel used by the transport vehicles to move the waste from collection sites to the bioreactor facility and to move leachate from the bioreactor site to the wastewater treatment facility (including energy used for leachate treatment). Energy expended during waste placement and landfill operations, $E_{operation}$, is the sum of placement fuel expenditures and facility electricity usage.

The results of the energy balance from the start of the operation of the bioreactor landfill until the end of 2006 will be presented. Attention will be given as to how bioreactor landfill operators can utilize energy balances to minimize energy consumption and maximize energy outputs. Measures affecting the energy balance will be discussed and technical constraints that can be mitigated in future designs will be highlighted.

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